



INVISIBLE HELPERS

**ACADEMY RESEARCHERS PEER INTO MYSTERIOUS
WORLD OF MICROBIAL COMMUNITIES**

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Whether they cause an infection or make someone sick, bacteria can be bad for humans. That much is clear.

What remains a mystery is how collections of certain bacteria and fungi actually help people and potentially make them healthier.

United States Air Force Academy cadets and faculty members have recently embarked on several cutting-edge research projects designed to unlock some of the secrets associated with beneficial microbes. The goal is to eventually isolate helpful microscopic organisms and use them for various military and civilian applications. Maj. Andrew Hoisington, assistant professor with the Department of Civil & Environmental Engineering, says he's been working on microbiome research for about six years. He says it's a scientific field that is in its infancy and teeming with intriguing possibilities.

As an environmental engineer, Hoisington's career has primarily focused on air quality in retail and commercial building settings. ►



Then I stumbled upon this microbiome stuff and it fascinates me,” he says.

Hoisington and Academy Assistant Biology Professor Katherine Bates, along with cadet researchers, have collaborated over the last few months to collect and identify microbial communities that live inside people’s bodies and also congregate on one’s skin and in individual work areas.

“Only within the last 15 years has the technology caught up with the knowledge that we have all of these microbes in [gut microbiome] and on and around us [environmental microbiome],” Bates explains. “We’re just at the beginning stages of identifying them.”

Until very recently, Bates says, most of the research on microbes and microbial communities focused on pathogens – the things that make people sick.

“The ones that didn’t seem to cause an obvious disease were less pressing to study,” she notes. “As a microbiologist, you would much rather study tuberculosis than something that doesn’t cause a disease ... because you just don’t have the time.”

But as scientists have spent more time looking at the less threatening bacteria and fungi, they discovered something remarkable, Hoisington says. Some microbes appear to have healthful attributes.

THE PROBIOTIC CRAZE

Go to any drug store or big box retailer and you’re bound to find over-the-counter supplement products and food items that tout their probiotic content.

Probiotic enthusiasts claim that ingesting the right kind of microbes can improve the function of your digestive system, make you healthier and boost your quality of life.

Hoisington doesn’t disagree with some of the claims, and he suggests there’s not yet enough reliable research to prove which microbes are the most helpful.

“Some people want to outpace the science,” he says. “But we’re not there yet.”

Hoisington reports there are approximately 3,000 different species of microbes in a person’s stomach at any given time. Probiotic manufacturers often isolate upwards of five to 10 positive bacteria strains and place them in supplement capsules or infuse them in a food product.

“We haven’t even identified what the good gut microbiome is,” Hoisington warns. “Until we identify that, we’re not going to be able to say how to exactly feed it, how to isolate it or how to change it.”

Hoisington suggests people avoid being caught up in the hype about probiotics until the science is more complete.

“The science is very exciting, so I can see why people are hyped up about it. But ... we’re really at the very beginning,” Bates adds. “We’re at the ‘what is there’ stage, and we’re beginning to start the ‘what does it do’ stage.”

WHAT DOES IT DO?

Academy researchers and cadet assistants began collecting microbial samples in early January to aid them in several grant-funded microbiome projects.

The Academy collaborates with several other universities through the Military and Veteran Microbiome Consortium for Research and Education (MVM-CoRE), which involves many academic disciplines in an effort to better identify problems and develop viable solutions.

The consortium (which includes the Academy, University of Texas, University of Maryland, University of Colorado and the Veterans Administration) is dedicated to helping the military and U.S. veterans by better understanding microbiome communities and how they can be manipulated to human advantage.

One promising microbiome finding is a bacterial strain that appears to reduce fear and anxiety in laboratory mice.

If the bacterial treatment eventually proves effective in humans, Hoisington says the VA and military experts hope to use the microbe to help veterans and soldiers who suffer from post-traumatic stress disorder (PTSD).

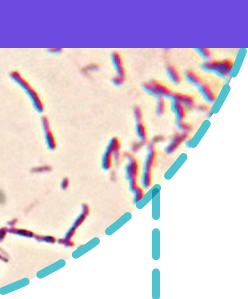
“The VA is particularly interested, because many of their veterans don’t like traditional medicine. They don’t want to take pills the rest of their lives,” Hoisington says. “Veterans are more open to alternative medicine, and probiotics would be non-traditional.”

Academy researchers are currently gathering blood and gut samples from 40 veterans with PTSD to identify all the microbes in their intestines and blood. The study volunteers also are participating in mental health evaluations and other medical tests.

Once a baseline for the participants is established, the volunteers will take daily capsules filled with billions of the suspected anxiety-reducing bacterial strains.

“Then we’ll see if it’s effective,” Hoisington says. “If we can reduce some of their symptoms of fear and anxiety, we could drastically improve the quality of life for millions of veterans suffering from PTSD.”

C1C Ryan Kissinger gram stained several bacterial samples so that he could take photographs of the bacteria that was collected. Pictured is one sample collected for the ongoing cadet research project on microbial communities.



Bacteria collected at the workplaces of United States Air Force Academy staff members was grown in petri dishes and examined for microbe types. Samples were taken over a three-week period to see what, if any, changes occurred in the microbial communities in the workplace.

A second ongoing project involves fighter pilots and the so-called “ice in their veins” myth. Researchers are studying the gut microbes in 100 fighter pilots and 100 spouses.

“We’re comparing the results with the spouse, who is eating the same types of food and is in the same environment,” Hoisington says. “We’ll see how their microbiome is different. That way we can answer the question of whether the fighter pilot’s microbiome is different from other people.”

If so, researchers hope to isolate the appropriate microbes that are unique to the fighter pilots and create supplements that could be helpful to those hoping to pursue stressful occupations.

“Can we make better fighter pilots? Pilots who are calmer and more under control?” Hoisington asks. “And it doesn’t stop with fighter pilots. There are a lot of people in jobs who would benefit from a reduction in fear and anxiety ... air traffic controllers, special ops, SWAT teams and police, to name a few.”

A third microbiome project centers on the bacteria and fungi people leave behind at home, at their desk or wherever they visit. Over the course of one hour, every individual deposits an estimated one million bacterial cells into his or her surroundings, Hoisington says.

“We’re kind of like the Pig Pen character in Peanuts,” he explains. “We’re constantly shedding these bacterial cells.”

Over a three-week period in January, cadet research assistants collected samples from the desks, computer mice, keyboards and offices of 20 faculty volunteers. The project explored how the microbial communities in each person’s surroundings change over time, and how bio-fingerprinting can help determine if a specific person was in a specific place at a specific time.

Hoisington says the project uses microbiome identification and DNA sequencing (conducted by a different university partner) to establish a full bio-fingerprint.

Hoisington says the military application of the research is significant, as microbiome testing of a location could verify if a terrorist or his accomplices have been in a building or home. Microbiome testing also could verify if a suspected terrorist has visited a foreign country (i.e. Syria or Pakistan) recently.

A fourth project, being conducted in conjunction with the University of Chicago, is examining at how a person’s microbiome changes when placed in close proximity to a group of strangers. Hoisington reports that people deployed for military service are typically sicker than the general population.

“Why is that? We don’t know,” he says. “Is it because they are in a high-stress environment? Is it because we have 12

people in a tent? Or are there other factors involved? Is it this microbial community idea?”

To study this concept, Academy researchers are sampling the microbiome of cadets who come to Colorado Springs from throughout the nation and around the world. An individual’s microbiome can vary based on what foods they eat, where they come from and who they live with.

The project will record how cadet microbial communities change as they interact with other students, and how their microbiome changes back when they go home for a long break.

“For deployers, the question is ... when they come home ... what are they bringing home to their families? And how quickly does their microbiome change back? Or does it change back?”

PRESENTING THE FINDINGS

When the research is completed, Hoisington says cadets hope to report their final results at the Colorado Springs Undergraduate Research Forum and at summer conferences and symposiums. By next Christmas, the group expects to publish a paper about the research in a peer-reviewed journal.

Hoisington emphasizes that undergraduate research, like that being conducted at the Academy today, benefits cadets in many ways. He says hands-on research engages students and helps them develop critical thinking skills.

Additionally, undergraduates involved in research typically have higher grade point averages and more often move on to graduate-level studies.

C1C Stephanie Ohms, who is serving as an assistant during the research, sees great value from her involvement.

“It allows me to apply the theories and skills I’ve learned in classes and apply them to real situations,” she says.

Ohms adds that she appreciates the chance to participate in cutting-edge research and hopes to continue to study more about microbial communities.

A PEEK INTO THE FUTURE

As the knowledge about beneficial microbes expands, scientists may be able to introduce higher populations of positive bacteria and fungi that could improve the overall health of Americans.

“Could we some day — just like we fluorinate our water today — add bacteria that has positive outcomes? It’s still a long way off, but you never know,” Hoisington comments.

“All of this is really exciting, because it shows us that we are more than our genes,” Bates adds. “Oftentimes, we perceive that we are in control of our environment. We build our houses and

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This semester’s microbial communities research crew includes C1C Ryan Kissinger, C1C Stephanie Ohms and C2C Amelia Roddenberry. The cadets were busy in January and February gathering microbe samples and studying changes that occur over time.

our buildings, and we control our temperature. Yet we don’t consider the microscopic and invisible environment. We really don’t know how they influence us.”

Today, most researchers agree that the microbiome impacts people to some degree, Hoisington notes.

“How much of an impact it has is very much misunderstood,” he explains. “Maybe I’m anxious and bite my nails because I have a bad microbiome, or a microbiome that’s conducive to that. Maybe I’m angry more often because of an imbalance in a microbiome. Fifty years ago we thought it was chemicals in our brain that caused these emotions and responses. But maybe some of these chemicals were caused by bacteria.”

Hoisington says only time, and much more research, will tell the full tale of how one’s microbiome impacts their everyday life.

“It could be huge,” he notes, “if the microbes prove to do what we think they might do.” 